

# Regulatory Update: Hexavalent Chromium in Drinking Water

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# Chromium

- Chromium can occur as a metal or in two ionic forms
  - ◆ Trivalent chromium (Cr<sup>3+</sup>)
  - ◆ Hexavalent chromium (Cr<sup>6+</sup>)
- Chromium in water is mostly naturally occurring
  - ◆ Cr<sup>3+</sup> found mostly in surface water
  - ◆ Cr<sup>6+</sup> found mostly in ground water
- USEPA is gathering national occurrence data under the third Unregulated Contaminants Monitoring Rule
  - ◆ Both total Cr and Cr<sup>6+</sup>



# CA UCMR Data on Cr6 in DW

(Data from 7000 sources, 2000-2011)

## Peak level (ug/L)

- >50
- 41-50
- 31-40
- 21-30
- 11-20
- 6-10
- 1-5

## Number of sources

- 7
- 3
- 17
- 63
- 243
- 484
- 1493

Data from 7000 sources, 2000-2011



# Current Chromium Regulatory Status

- MCL for total chromium [Cr3 + Cr6] is based on Cr6 toxicity (Cr3 is an essential nutrient)
  - ◆ USEPA MCL = 100 ug/L
  - ◆ California MCL = 50 ug/L
- No federal or state MCL specific for Cr6 alone
- CA legislature enacted a law in 2001 to require Cr6 MCL, but no proposal yet
- USEPA reconsidered chromium MCL in recent 6-Year Review, but passed on revision at that time
  - ◆ Lacked adequate health, occurrence data



# Erin Brockovich, “Erin Brockovich” and Public Perceptions of Cr6

- Pacific Gas and Electric used Cr6 for corrosion control in its cooling towers in Hinkley, CA, and elsewhere
  - ◆ Contaminated water got into aquifer
  - ◆ PG&E lied about it
- EB championed the issue, helped win a \$333M settlement in 1996, got a movie made
- EB led a similar lawsuit in Kettleman City, got them \$335M in 2006 settlement (but no sequel)
- Neither case ever argued on merits of toxicity
  - ◆ CA DPH epidemiology study showed no health impacts



# Glendale, Burbank, LADPW, et al

- Superfund sites in San Fernando Valley for solvents, Cr6 in groundwater
  - ◆ Leftovers from aircraft fabrication
- EPA got involved, 1989
  - ◆ Three wells over 50 ug/L Cr6 found in 1997
- Glendale, Burbank, LA, CA DTSC, Watermaster and LA Regional WQ Control Board formed management group in 1997
- EPA began investigation of Cr6 sources in 1999



# Erin Speeds Up Cr6 Activities

- EB got involved in 2000
- 2000 election year maneuvers
  - ◆ Hearings and media events
  - ◆ EB showed her stuff
- Senators Boxer and Reid proposed federal Cr6 MCL legislation in 2001 (went nowhere)
- CA legislature enacted law in 2001 to require Cr6 MCL
- Glendale city council decided 5 ug/L Cr6 for city DW
  - ◆ Superfund to pay the costs



# Consequences...

## How Do You Get Cr6 <5 ug/L?

- Glendale, Burbank, LADWP, et al, pooled resources and began AWWARF treatment project
- Newly-elected Rep Schiff provided series of EPA grants for treatment research
- Open, flexible R&D process allowed best approaches to emerge
- R&D started small and wide
- Moved to bench and pilot scale as data indicated
- Allowed new questions to get answered



# Current Chromium R&D

- Drinking water community fostering needed research
  - ◆ Pilot studies on treatment approaches
  - ◆ Cost evaluations
  - ◆ Treatment residuals management
- Other CA utilities now doing treatment work
  - ◆ Livermore, Davis, Coachella Valley, Soquel Creek, etc
- Other sources of Cr6 also need examination
  - ◆ Drinking water disinfectants can oxidize Cr3 to Cr6 in distribution system
  - ◆ Cr6 can bind, accumulate and be released from distribution system materials and sediments
  - ◆ Cr6 may occur in other DW treatment chemicals



# The Evolution of Cr6 Health Risk Assessments

- Trivalent chromium (Cr3) is an essential nutrient
  - ◆ Blood sugar control
- Hexavalent chromium (Cr6) is toxic
  - ◆ Airborne Cr6 tissue damage, skin sensitization, rashes
  - ◆ Cr6 is an oxidant, “burns” tissue
  - ◆ Long-term oxidation may yield secondary effects
- 1991 MCL based on RfD with no adverse endpoint
- IRIS RfD (1998) at 3 ug/kg/d (~100 ug/L)
  - ◆ Similarly based on no adverse endpoint



# Cr6 as a Carcinogen, 1998

- EPA reconsidered carcinogenicity (1998 IRIS)
  - ◆ Lung damage from Cr6 plating mists, aerosols
  - ◆ Lung cancer in humans from inhalation
  - ◆ Probably from oxidation resulting from metabolic reduction of Cr6 to Cr3
- “The oral carcinogenicity of Cr(VI) cannot be determined. No data were located in the available literature that suggested that Cr(VI) is carcinogenic by the oral route of exposure.”
- CA OEHHA assumed Cr6 was an oral carcinogen, because of its inhalation carcinogenicity



# Evolution of Cancer Risks

- National Toxicology Program studies, 2005-07
  - ◆ Tested oral exposure of Cr6 in rats, mice
  - ◆ Found elevated mouth and intestinal epithelial neoplasms, starting around 20 mg/L in mice
  - ◆ Doses to 180 mg/L did not kill animals
- Rapid reduction from Cr6 to Cr3 occurs in stomach
  - ◆ DeFlora, et al (2008) suggested effects threshold as reduction (detoxification) capacity is exceeded



# Cr6 Cancer Mode of Action

- Mode of Action (MOA) describes how something could be toxic
- For carcinogens, some can damage DNA, chromosomes directly (genotoxicity)
- Some carcinogens kill cells; healing process can trigger cancer (cytotoxicity)
- CA OEHHA considers Cr6 primarily genotoxic, with no threshold for effects
- Other data indicate that Cr6 cytotoxicity dominates at lower exposures
  - ◆ Cytotoxicity has a threshold
  - ◆ Data of Proctor, et al, support this hypothesis



# Current Cr6 Health Risk Thoughts

- CA OEHHA finalized PHG at 0.02 ug/L on July 27, 2011
- ◆ PHG set at 1/million risk level
- ◆ Did not consider detoxification as risk reduction
- ◆ Used linear, no threshold extrapolation
- EPA is reconsidering its risk assessment
- ◆ EPA withdrew 2010 draft after peer review
- ◆ EPA considering the new data on Mode of Action of carcinogenicity
- ◆ Unclear when new draft will appear



# Regulatory Construction

- A drinking water regulation needs several things:
- Health risk information
  - ◆ Is it a problem at the levels found?
- Suitable quantitative analytical methods
- Occurrence information
  - ◆ What levels is it found at?
  - ◆ Where, when?
- Feasible treatment technologies
- Holistic cost information (i.e., for everything)
- Benefit-cost analysis (is it worth it?)



# On With the Show...

- CA DPH is using the PHG, occurrence data and treatment information to develop a Cr6 MCL
  - ◆ May have proposal mid-2013
- USEPA will also be able to use these data for next 6-Year Review
  - ◆ May decide to revise the existing chromium MCL
- Although largely fortuitous, parallel tracks for treatment, risk and occurrence research are yielding timely information



# Total Chromium MCL vs. Hexavalent Chromium MCL

- Unlike CDPH, EPA has an option: Revise the current chromium MCL
  - ◆ Groundwater is mostly Cr6
  - ◆ Surface water is mostly Cr3
- Because of possible oxidation during treatment or in distribution systems (Cr3 → Cr6), revising total Cr MCL downwards might be best
- EPA will collect data in upcoming UCMR3



# Rendezvous with Destiny

- CDPH will decide on where to set their MCL
- Should a Cr6 MCL be compared to the arsenic MCL at 10 ug/L?
  - ◆ Compliance, treatment, cost issues similar
- Implementation issues could be important
  - ◆ Most of the systems with elevated Cr6 are small GW systems
  - ◆ Few, if any, will have Glendale's Superfunding





Drinking water from a public supply is  
about the safest thing you do